

A Variable Averaging Period Scheme For Real-Time Mapping of PM_{2.5}

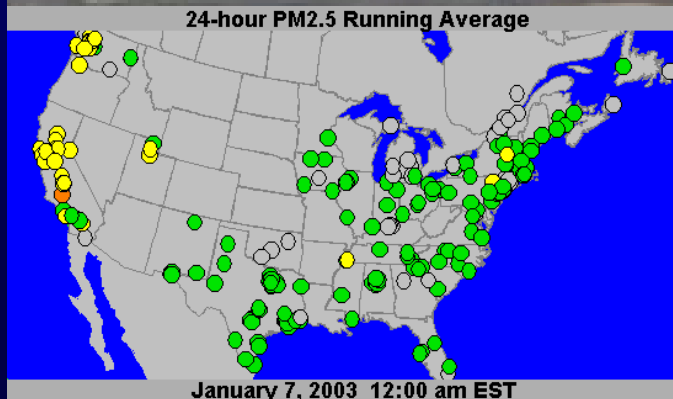
Lewis Weinstock

Forsyth County Environmental Affairs Department

Winston-Salem, North Carolina

336-727-8060

weinstl1@co.forsyth.nc.us



01/08/2003 10:46 AM

Real Time Mapping of PM2.5

The Problem

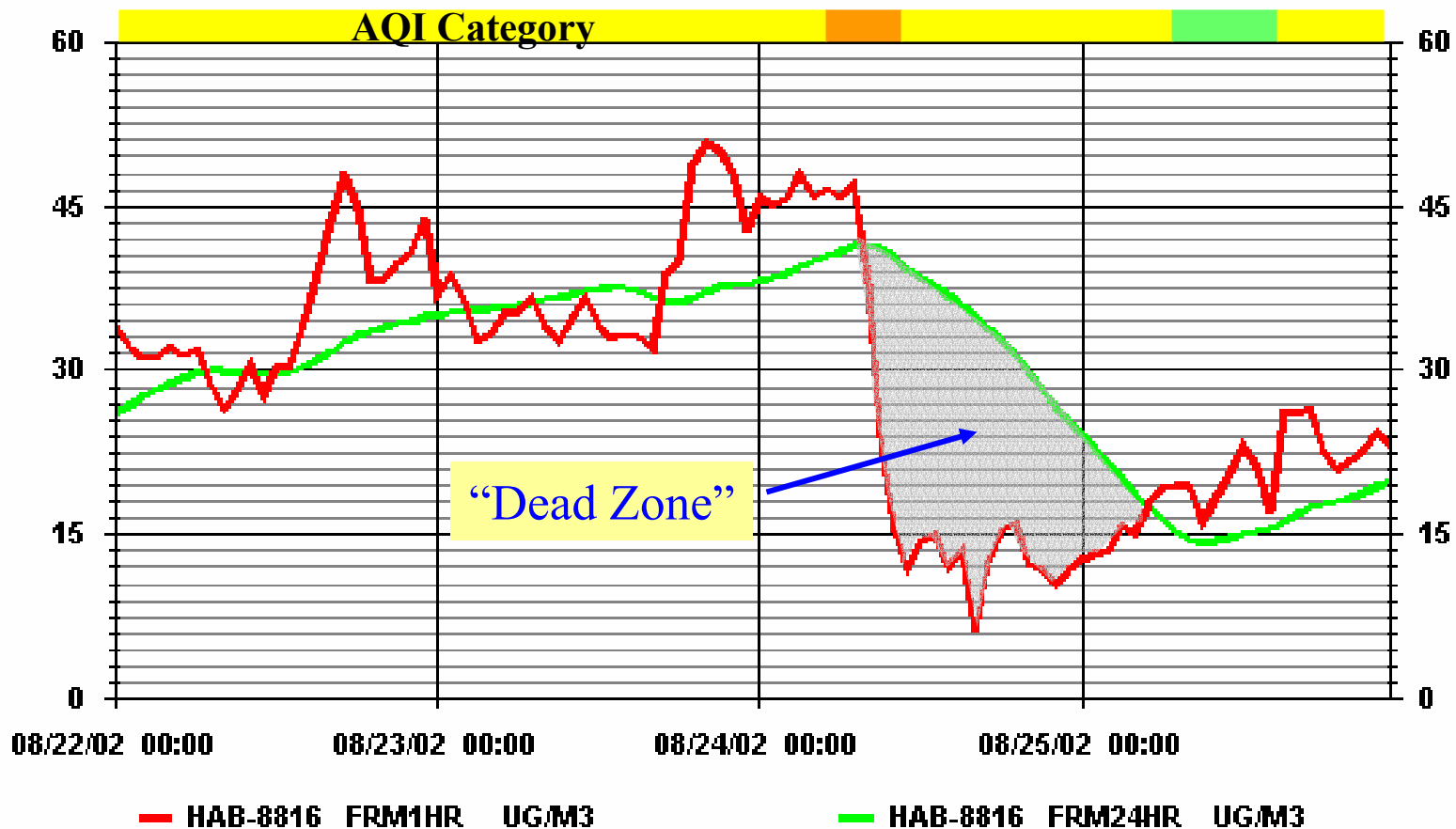
- The National Ambient Air Quality Standard for PM2.5 requires averaging over a 24-hour period.
- Continuous monitors have shown that short term levels of PM2.5 react quickly to changes in meteorology and source emissions.
- The result is potential for a “discontinuity” between 24-hr PM2.5 based AQI readings and real time conditions that can be confusing to the public.



Continuous PM2.5 monitor

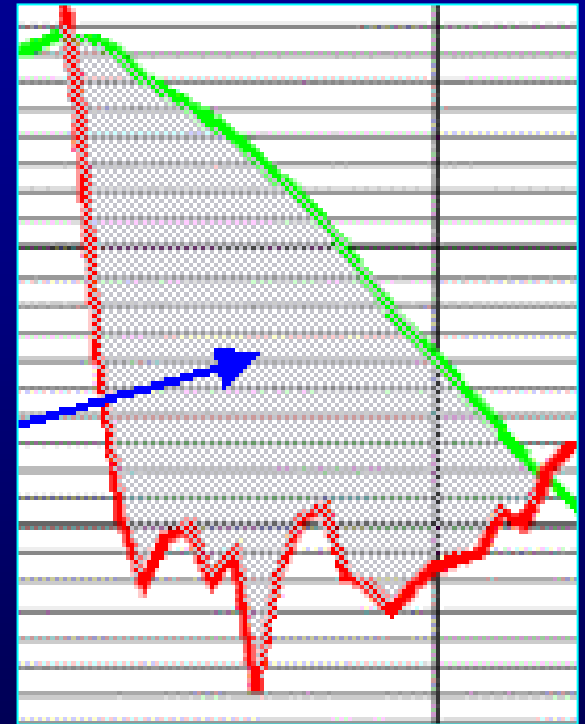
When Is This a Problem?

Comparing 1-Hr and 24-Hr Response Rates


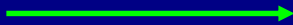




Why Do We Care?

- AQI data systems will indicate conditions much worse (or better) than short term levels.
- The public may take unnecessary health precautions after high levels have passed.
- Web cam pictures and real time maps may conflict with the “look” of ambient conditions.
- Try explaining this to your TV meteorologist.



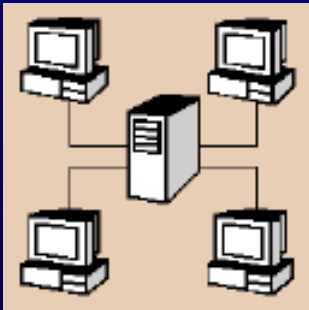
Shorten PM2.5 Averaging Period

- 3hr 
 - Response includes **brief, local effects** like mowing, instrument “burps”, and precipitation events.
 - Rush hour mobile source peaks can dominate response.
- 6hr 
 - **Tracks** rapid air mass changes nicely.
 - Still far from health based averaging period.
- 12hr 
 - **Balances** quicker response with closeness to NAAQS.
 - Can lag rapid ambient changes.
- 24hr 
 - **Only** period consistent with health based research in the NAAQS.
 - Badly **lags** even moderately paced ambient changes.

Proposal: Design a Variable Averaging Period Scheme for Mapping PM2.5

Utilize the **RATIO** of running (6hr/24hr) PM2.5 averages to assess the rate of change of ambient concentrations and display a map more “in-synch” with real time.

- **DMC Requirements**



- Calculate running 6hr, 12 hr, 24hr averages for each PM2.5 site on hourly basis.
- Calculate the (6hr/24hr) ratio “on the fly” each hour.
- Map the appropriate averaging interval for each monitor according to decision rule.

Decision Rule

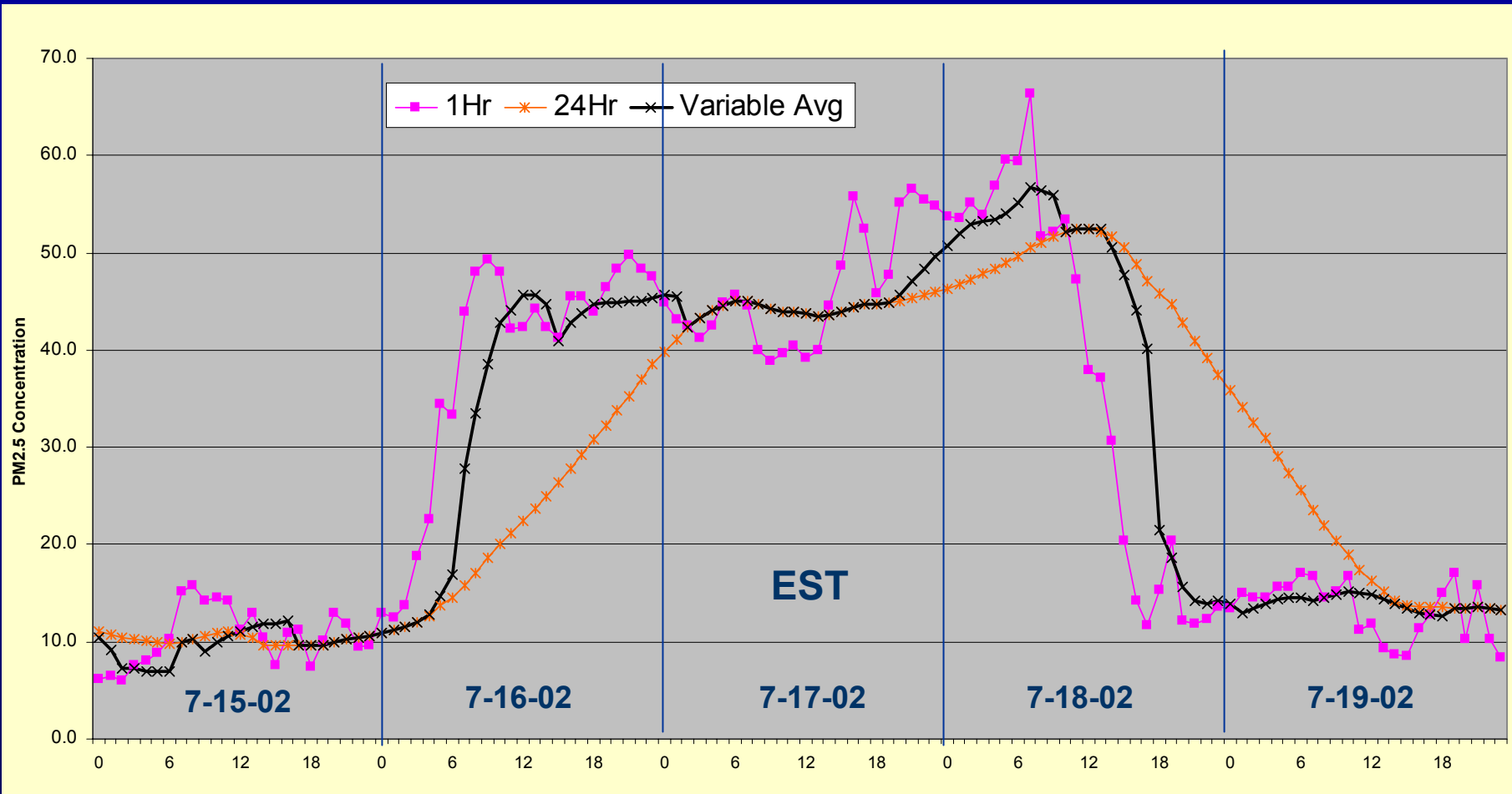
(6hr/24hr) ratio of PM2.5	Mapping Period on animations	Δ PM2.5 Levels
0.90 to 1.10	24 hour	Slow
1.11 to 1.75 0.50 to 0.89	12 hour	Moderate increase Moderate decrease
>1.75 <0.50	6 hour	Rapid increase Rapid decrease

PM2.5FRM Equivalent

Hattie Avenue 37-067-0022-88101-3

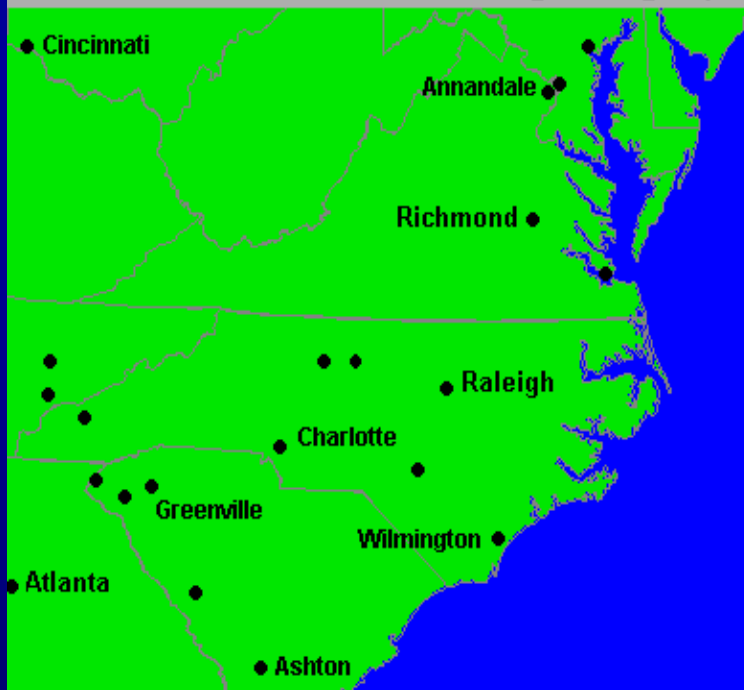
Backward averaging periods						Map the Colored Averaging Period			Final
EST	1-hr	6-hr	12-hr	24-hr	Analysis of 6-hr/24-hr ratios			Mapped Conc and AQI Color	
					Map 6hr	Map 12hr	Map 24hr		
07/16/02	1	12.5	11.6	10.7	11.2	1.04	1.04	1.04	11.2
07/16/02	2	13.8	11.7	10.9	11.5	1.02	1.02	1.02	11.5
07/16/02	3	18.8	12.8	11.9	12.0	1.07	1.07	1.07	12.0
07/16/02	4	22.6	15.0	12.8	12.6	1.19	1.19	1.19	12.8
07/16/02	5	34.5	19.1	14.7	13.7	1.39	1.39	1.39	14.7
07/16/02	6	33.3	22.5	16.9	14.6	1.54	1.54	1.54	16.9
07/16/02	7	44.0	27.8	19.7	15.8	1.76	1.76	1.76	27.8
07/16/02	8	48.1	33.5	22.6	17.1	1.96	1.96	1.96	33.5
07/16/02	9	49.3	38.6	25.7	18.6	2.08	2.08	2.08	38.6
07/16/02	10	48.0	42.8	28.9	20.0	2.14	2.14	2.14	42.8
07/16/02	11	42.2	44.1	31.6	21.1	2.09	2.09	2.09	44.1
07/16/02	12	42.4	45.6	34.1	22.4	2.04	2.04	2.04	45.6
07/16/02	13	44.3	45.7	36.7	23.7	1.93	1.93	1.93	45.7
07/16/02	14	42.3	44.7	39.1	25.0	1.79	1.79	1.79	44.7
07/16/02	15	41.2	43.4	41.0	26.4	1.64	1.64	1.64	41.0
07/16/02	16	45.5	42.9	42.9	27.8	1.54	1.54	1.54	42.9
07/16/02	17	45.5	43.5	43.8	29.3	1.48	1.48	1.48	43.8
07/16/02	18	44.0	43.8	44.7	30.8	1.42	1.42	1.42	44.7
07/16/02	19	46.4	44.1	44.9	32.3	1.37	1.37	1.37	44.9
07/16/02	20	48.4	45.1	44.9	33.8	1.33	1.33	1.33	44.9
07/16/02	21	49.8	46.6	45.0	35.3	1.32	1.32	1.32	45.0
07/16/02	22	48.3	47.0	45.0	36.9	1.27	1.27	1.27	45.0
07/16/02	23	47.5	47.4	45.4	38.5	1.23	1.23	1.23	45.4
07/17/02	0	44.8	47.5	45.6	39.8	1.19	1.19	1.19	45.6
07/17/02	1	43.2	47.0	45.5	41.1	1.14	1.14	1.14	45.5
07/17/02	2	42.5	46.0	45.5	42.3	1.09	1.09	1.09	42.3
07/17/02	3	41.2	44.5	45.5	43.3	1.03	1.03	1.03	43.3

Example Data



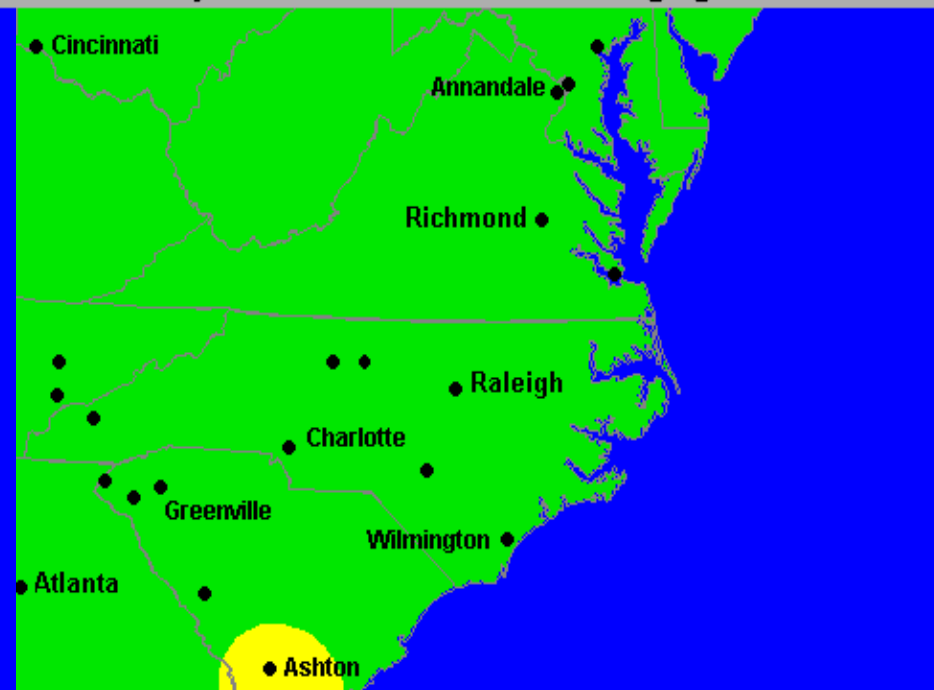
The variable averaging scheme “anticipates” the true 24 hour running average during rapid ambient changes to present a more dynamic indicator of PM2.5 levels for mapping use.

PM2.5 24-hour Running Averages (AQI)









July 15, 2002 12:00 am EST

PM2.5 Hourly Data based on Variable Averaging Period Scheme



July 15, 2002 12:00 am EST

Air Quality Index (AQI)		$\mu\text{g}/\text{m}^3$
	Good	< 15.5
	Moderate	15.5 - 40.4
	Unhealthy for Sensitive Groups	40.5 - 65.4
	Unhealthy	65.5 - 150.4
	Very Unhealthy	> 150.4
	Data Not Available	-

—Animations courtesy of Alan Chan & Craig Anderson (Sonoma) and John White (EPA).

Variable Averaging Period Scheme

😊 Advantages

- More representative of real time PM_{2.5} levels.
- Maps and derived AQI may be truer to ambient conditions.
- Provides balance between very short averaging times and actual 24-hr NAAQS.

😞 Disadvantages

- Maps are combination of different averaging times for each monitor.
- Uses non-NAAQS averaging period.
- Health interpretations uncertain.
- Requires server resources for calculations.
- Too complex for public explanation?

Questions?